Standard RECO and Particle Flow Comparison in a simple SUSY selection

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Outline

- Introduction
- Technical details
- Significance
- Event by event comparison
- MET differences PF vs SR
- Jet Differences PF vs SR
- Jet Differences for accepted events
- Conclusions

Introduction

- In our Previous presentation http://indico.cern.ch/getFile.py/access?contribId=1&resId=0&materialId=slides&confId=80846 an isolation study comparing Particle Flow leptons and Standard RECO leptons was performed, it was based on the analysis note CMS AN 2009-167.

- We reported a increase in the significance when only Particle Flow framework was used with respect to the same analysis using only the Standard RECO framework.

- What was happening, and why Particle Flow framework was showing better significances was not understood at the moment.

- An event by event comparison was done to understand the differences

Technical Details

PAT production

- CMSSW_3_1_4
- PAT Layer1 V6 recipe as appears at https://twiki.cern.ch/twiki/bin/view/CMS/SusyPatLayer1DefV6

PF2PAT production

- CMSSW_3_3_6
- PF2PAT recipe posted on Nov 17 2009 at https://twiki.cern.ch/twiki/bin/view/CMS/WorkBookPF2PAT#3_3_2

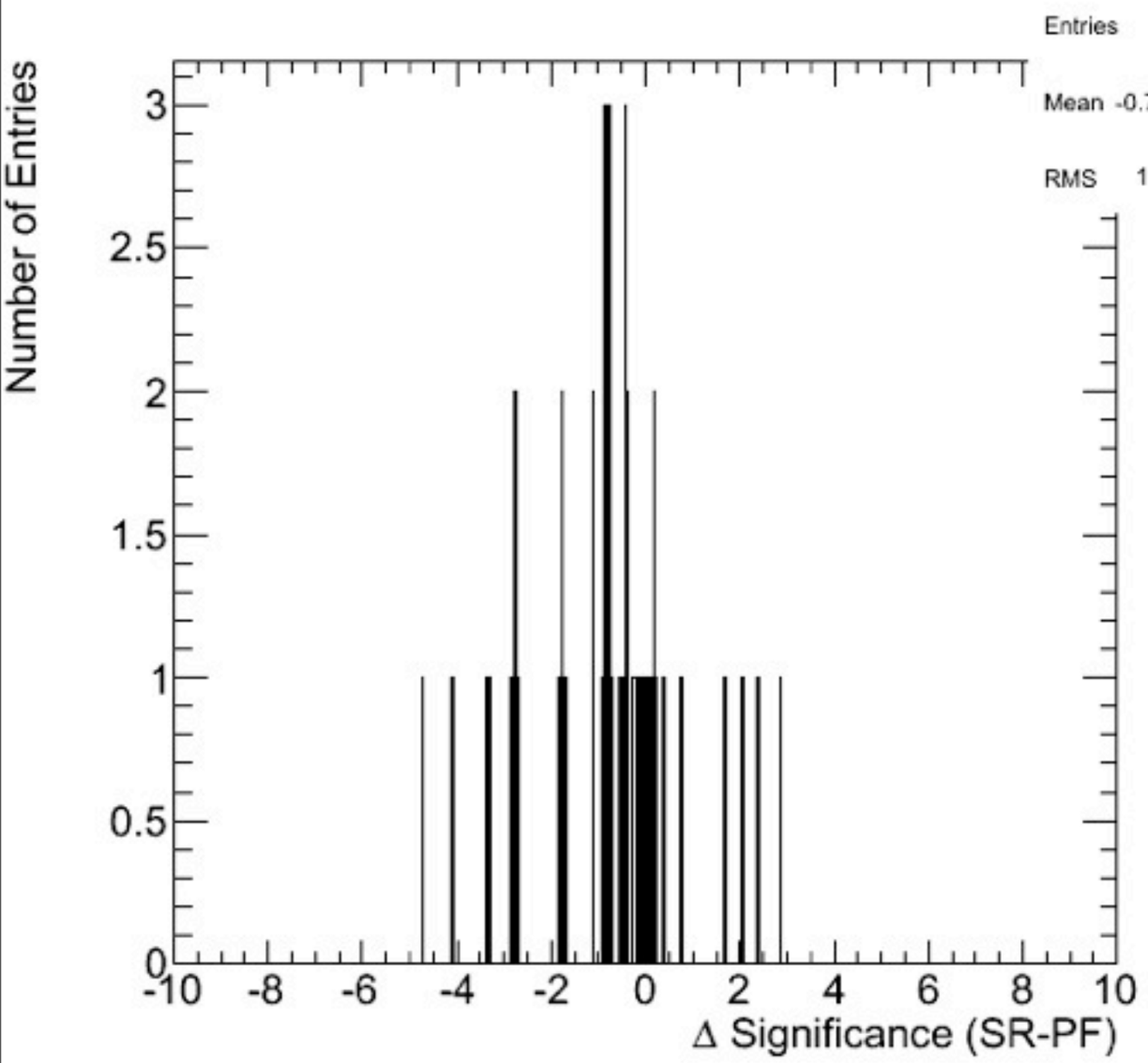
Samples Used

- /LM0/Summer09-MC_31X_V3_7TeV-v1/GEN-SIM-RECO
- /LM1/Summer09-MC_31X_V3_7TeV-v1/GEN-SIM-RECO
- /InclusiveBB_Pt30/Summer09-MC_31X_V3_7TeV-v1/GEN-SIM-RECO
- /QCD_Pt250to500-madgraph/Summer09-MC_31X_V3_7TeV_preproduction-v1/GEN-SIM-RECO
- /QCD_Pt500to1000-madgraph/Summer09-MC_31X_V3_7TeV_preproduction-v1/GEN-SIM-RECO
- /QCD_Pt1000toInf-madgraph/Summer09-MC_31X_V3_7TeV_preproduction-v2/GEN-SIM-RECO
- /TTbarJets-madgraph/Summer09-MC_31X_V3_7TeV-v2/GEN-SIM-RECO
- /WJets-madgraph/Summer09-MC_31X_V3_7TeV_preproduction-v1/GEN-SIM-RECO

SR and PF PATtuples

- /LM0/aocampor-LM0_7TeV_PF2PATandPATuple_OCAMPO-15b965e62687e4f6db82f42f1f6c01bb/USER
- /LM1/aocampor-LM1_7TeV_PF2PATandPATuple_OCAMPO-15b965e62687e4f6db82f42f1f6c01bb/USER
- /InclusiveBB_Pt30/aocampor-InclusiveBB_pt30_7TeV_PF2PATandPATuple_OCAMPO-15b965e62687e4f6db82f42f1f6c01bb/USER
- /WJets-sherpa/aocampor-WJets_Sherpa_7TeV_PF2PATandPATuple_OCAMPO-15b965e62687e4f6db82f42f1f6c01bb/USER
- /TTbar/aocampor-TTBar_7TeV_PFandSR_PATuple-0a1e07c60398cfce2869c3da73cc3b45/USER

Significance Difference between frameworks



64 entries corresponds to:

2 signal LM0, LM1
Single lepton e, mu
Double lepton same sign ee,mumu,emu
Double lepton opposite sign ee,mumu,emu
4 isolation cuts by case

- Calculating the significance difference between a pure Standard RECO selection and a pure Particle Flow selection one gets a visible increase in significance for Particle Flow Framework. (Check backup tables)

- Where was that difference coming is the issue of the next slides.

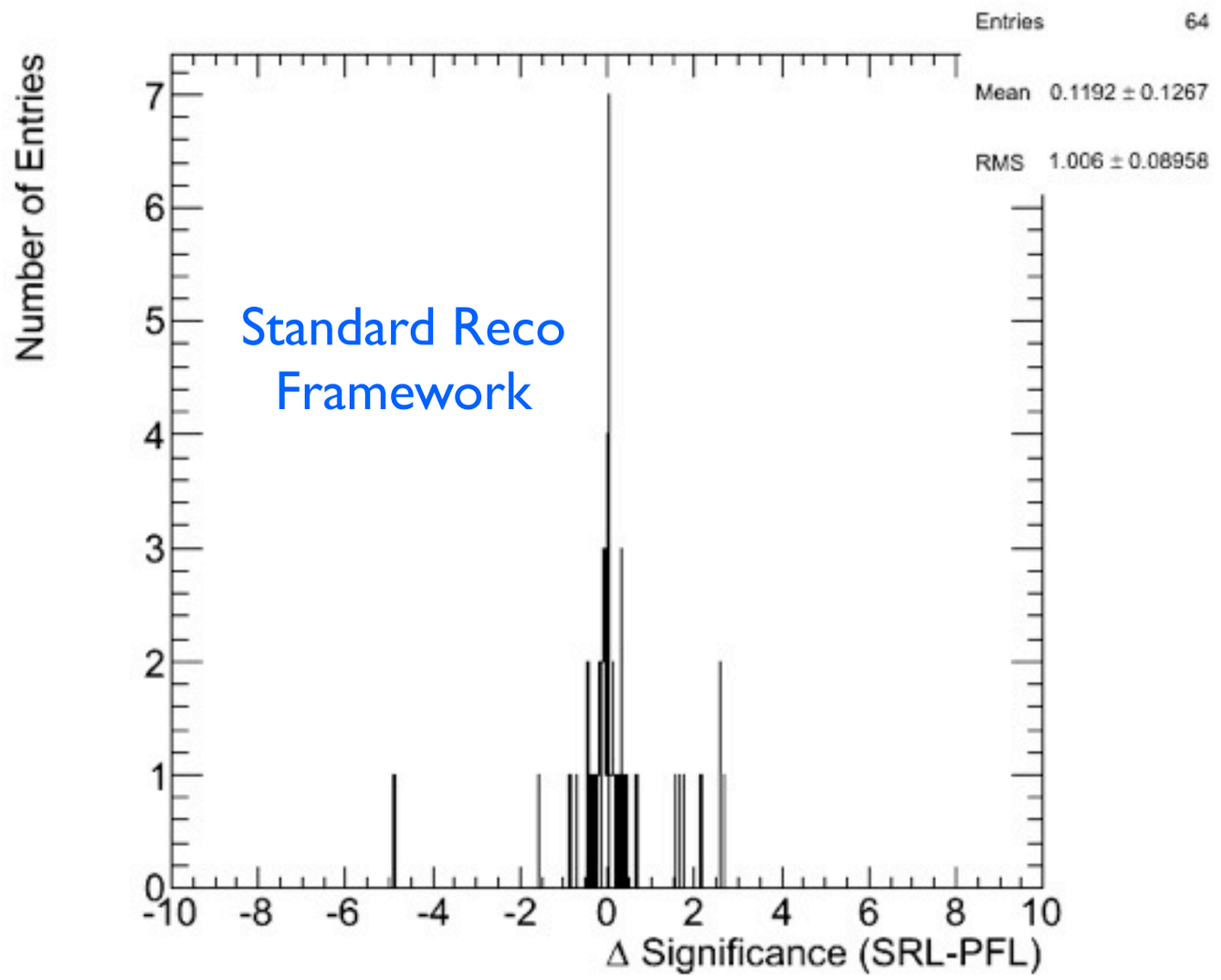
Significance Changing only leptons

- In a previous meeting, one of the comments suggested to fix Jets and MET in one of the frameworks and then study the variations in significance due to leptons only

- The following plots show the difference in significance for Standard RECO leptons and Particle Flow leptons fixing either Standard RECO Jets and Met or Particle Flow equivalents

- The significance was calculated for Single lepton selection, Same sign double lepton selection, and opposite sign double lepton selection as was stated in the previous presentation (see the link in the slide 3)

- No significant difference between these two frameworks was observed, however Standard RECO leptons have a slightly better performance (see tables in the backups)



Event by event comparison

I took a LM0 sample

↓

I run a Single Lepton Electron selection

↓

I divided the events that passed at least one cut in to

↓

SR MET and JETS with SR leptons (SRSRL)
SR MET and JETS with PF leptons (SRPFL)
PF MET and JETS with SR leptons (PFSRL)
PF MET and JETS with PF leptons (PFPFL)

~ ***20*** % of the accepted events are different in PF and SR due to lepton isolation issues.

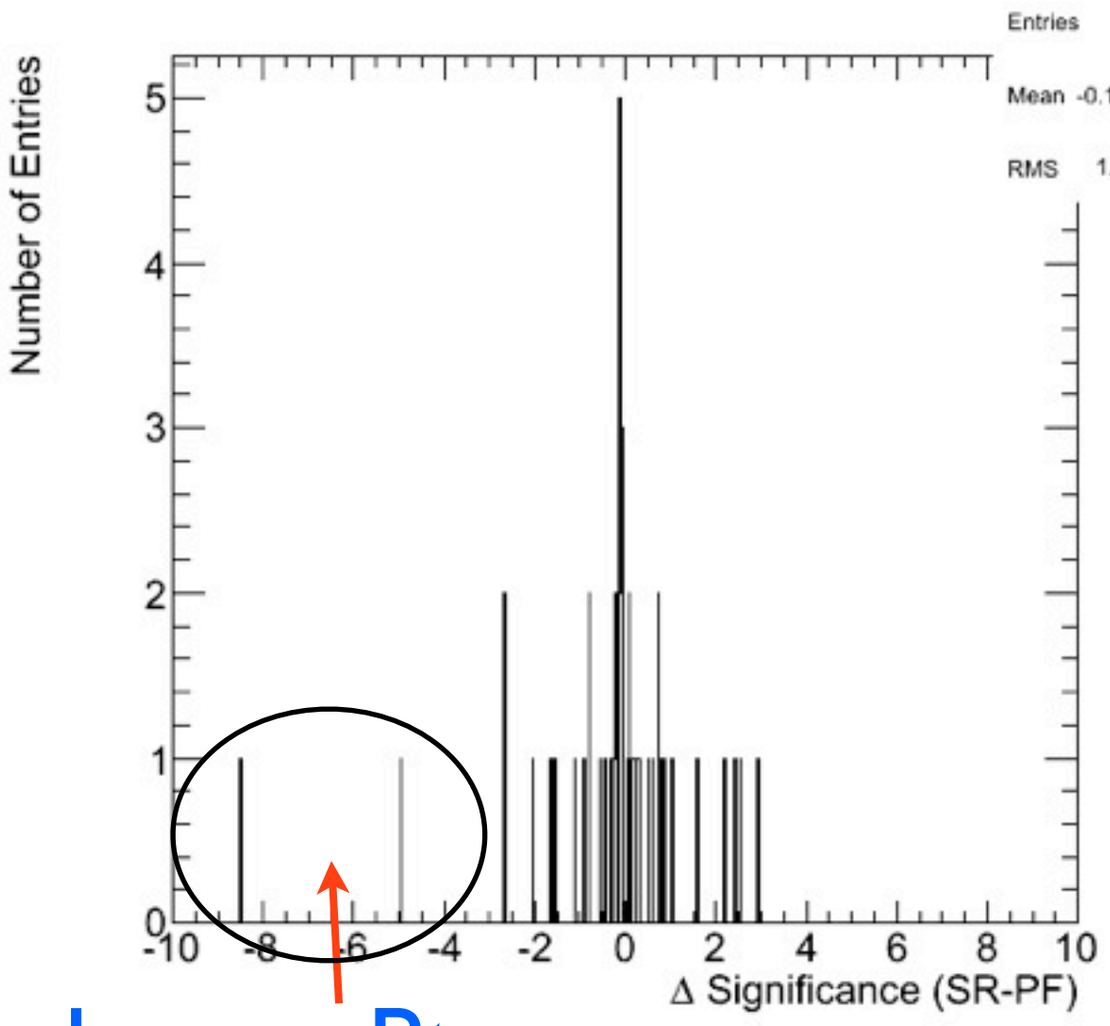
~ ***40*** % of the accepted events are different in PF and SR due to PF Jets.

~ ***2*** % of the accepted events are different in MET.

~ ***38*** % of the accepted events present no difference in rejection.

At this point we noticed that differences due to jets in the event selection were coming from the fact that Standard RECO jets were not cleaned from electrons, the cleaning was applied manually.

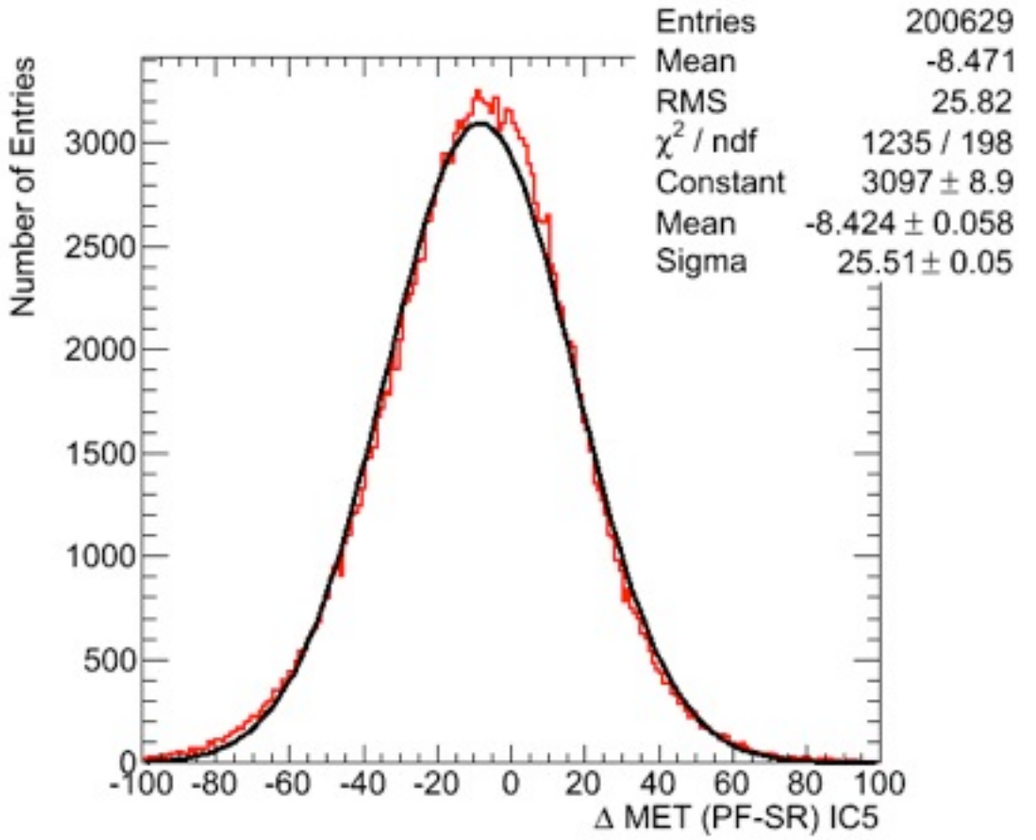
Significance Difference between frameworks revisited

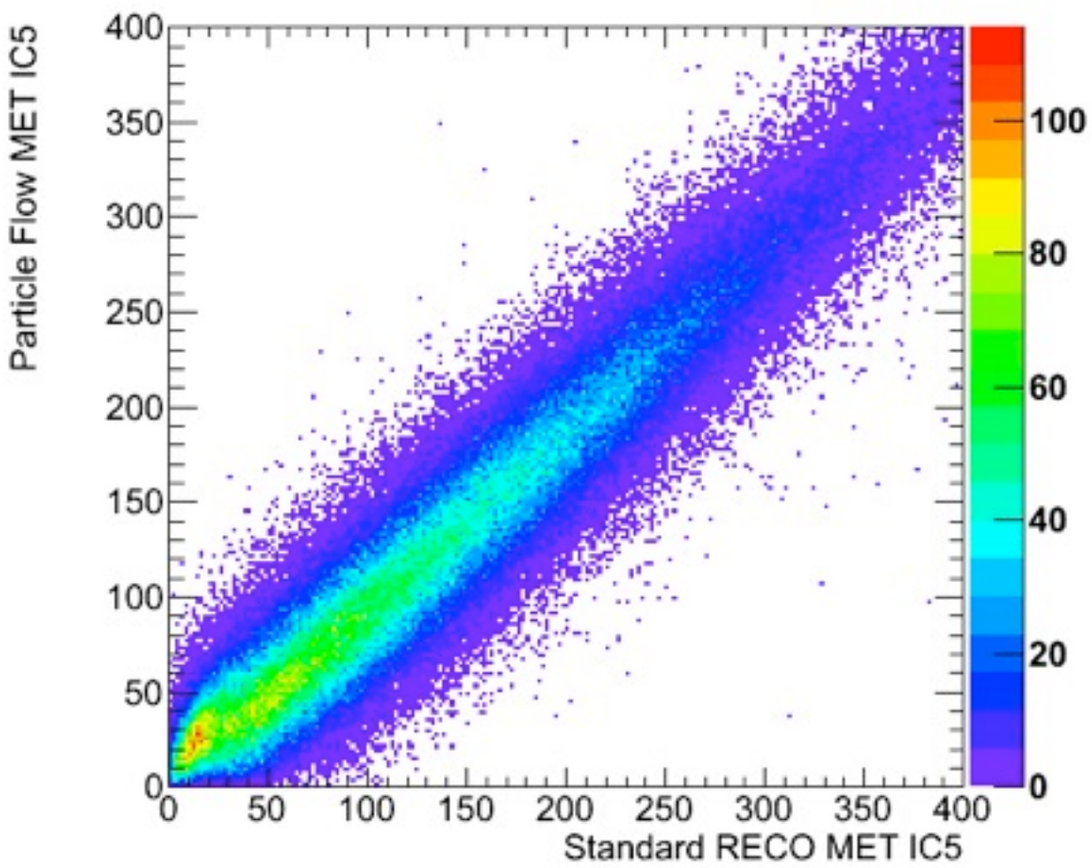


- This time the significance differences are not dramatic, however one can see some entries in the negative side of the plot, which means Particle Flow significance is better, those cases corresponds to the leptons of lower pt..., pt > 5 GeV or pt > 2 GeV.

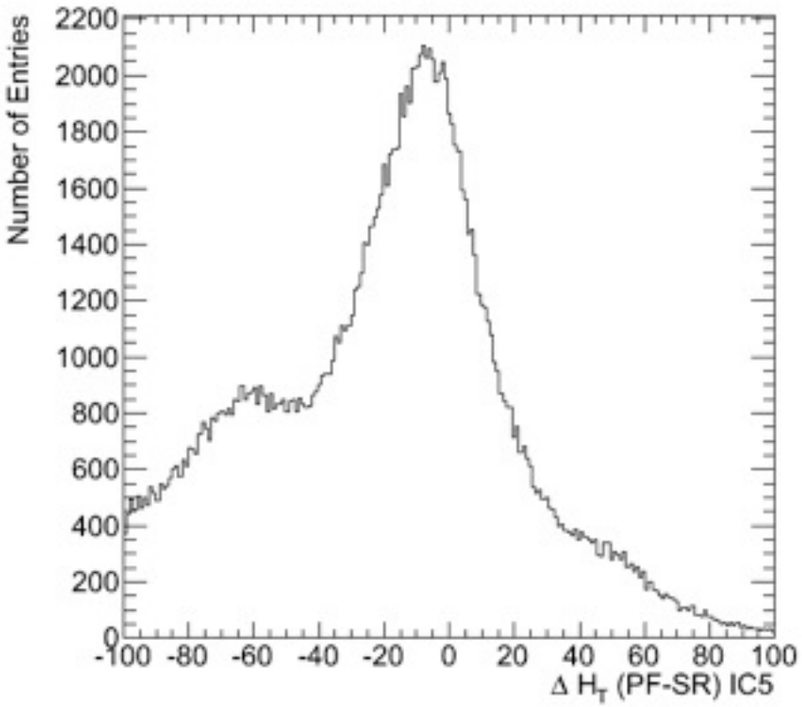
Difference in MET

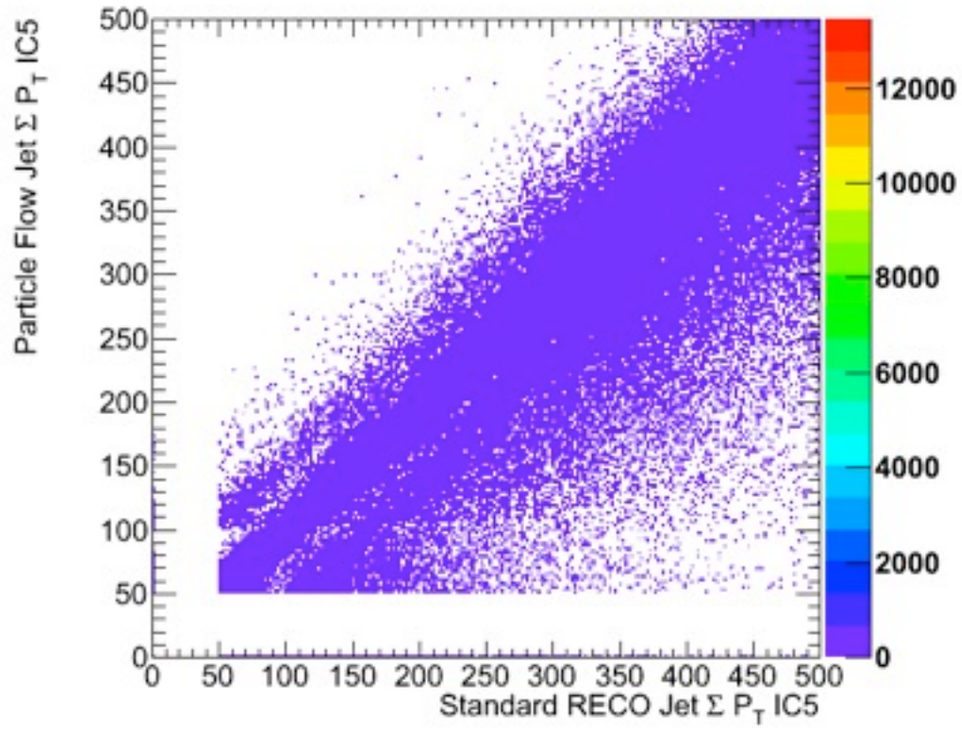
- Only **2%** of the events where different due to MET
- A shift of 8 GeV between both MET can be tell

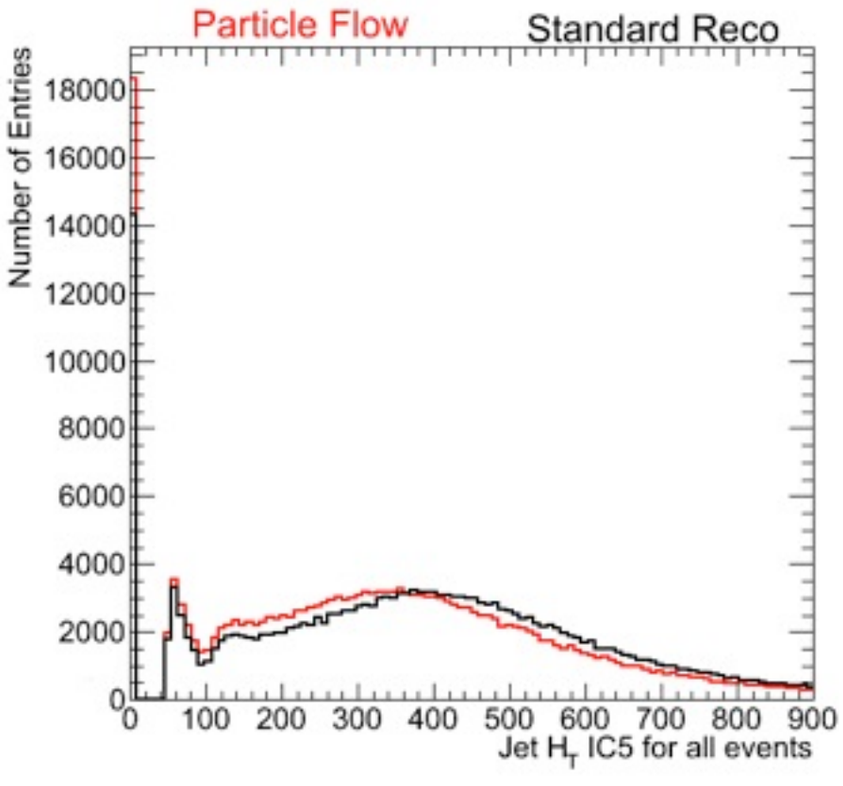




Jets differences



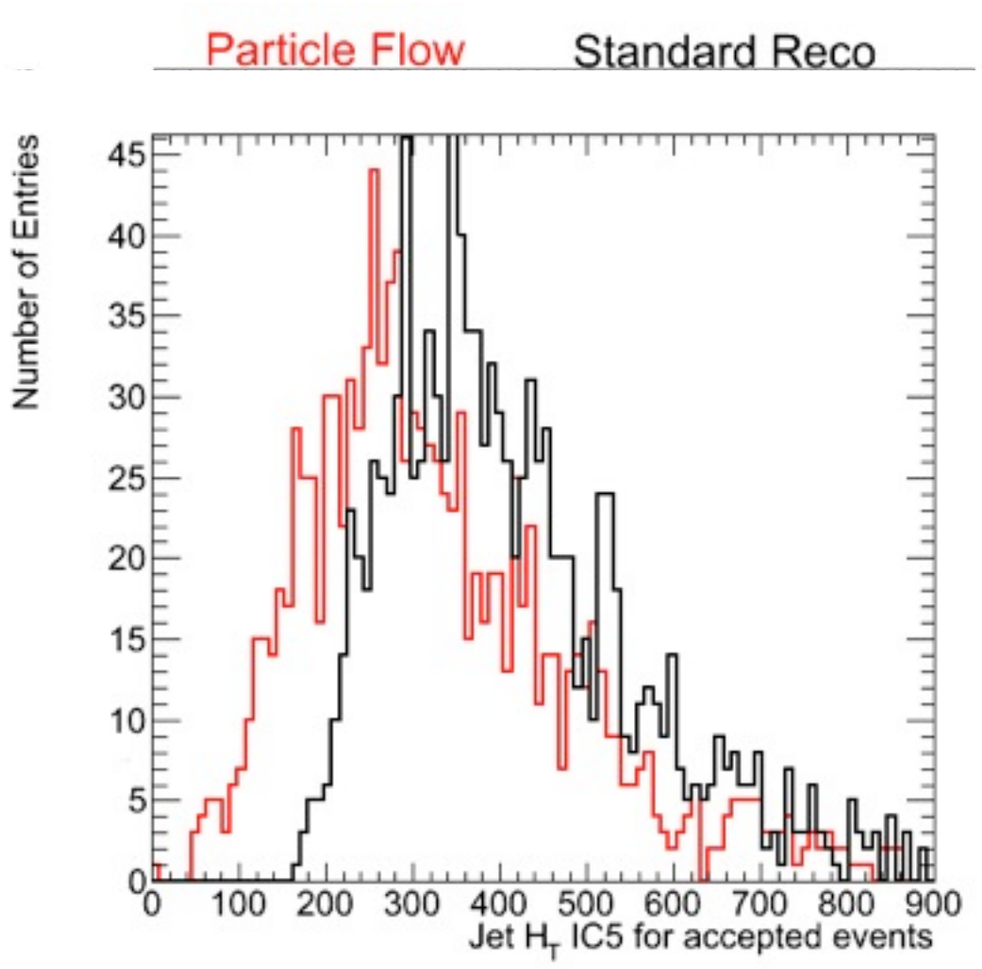




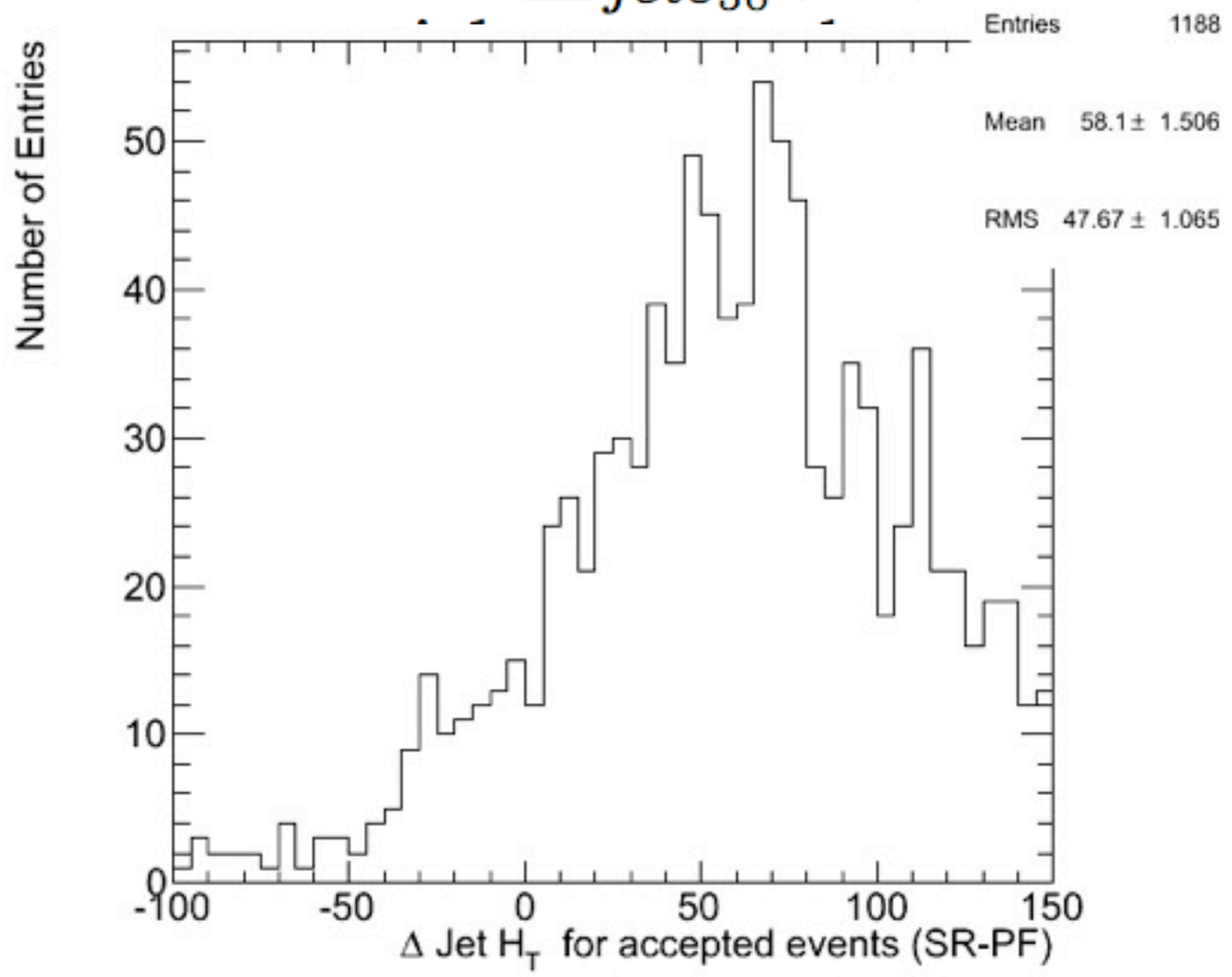
- Plotting Particle Flow Jets Ht minus Standard RECO Jets Ht, one can see that there is an excess of SR Ht. (Top)
- The Ht distribution for all jets shows that the Ht are not exactly equal (Bottom-left)

Jet difference for accepted events

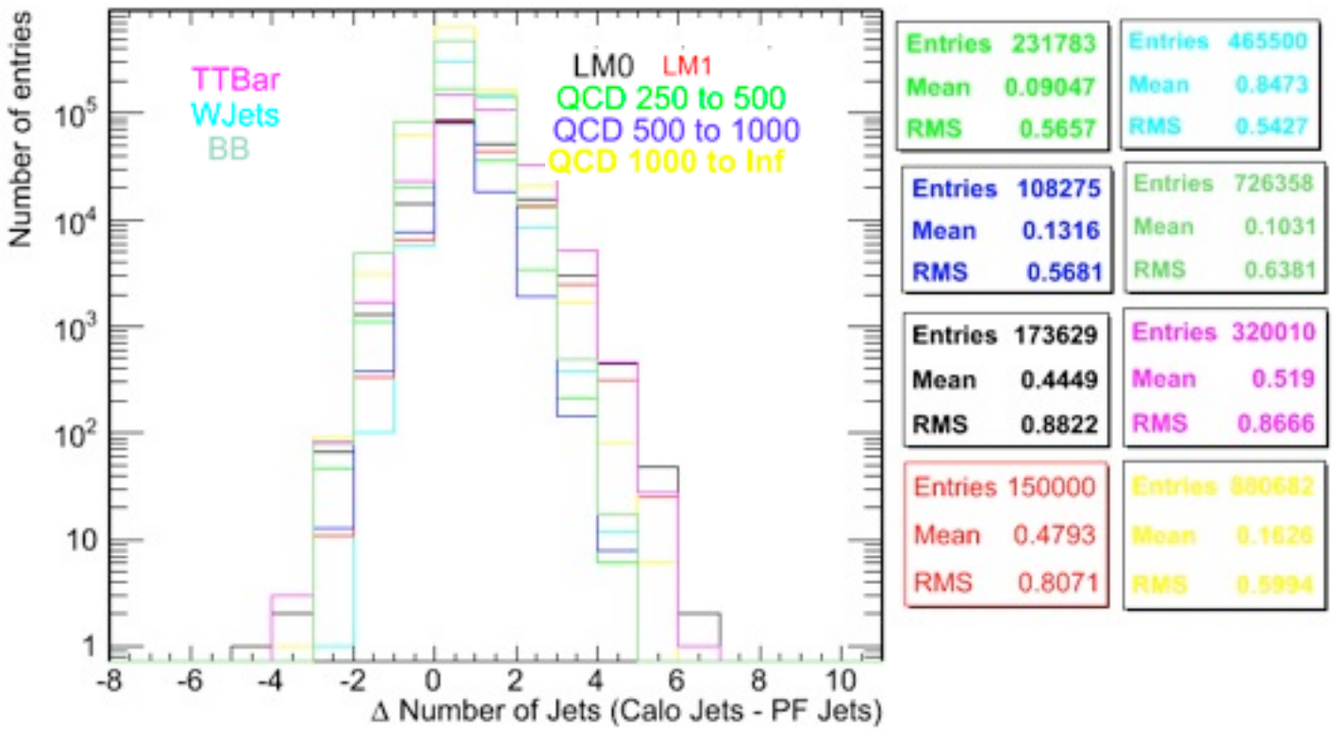
- Taking the difference between Standard RECO Jets Ht and Particle Flow Jets Ht only for those events that were accepted, we have that in average, SR Jets have 58.1 GeV of Ht more than PF Jets

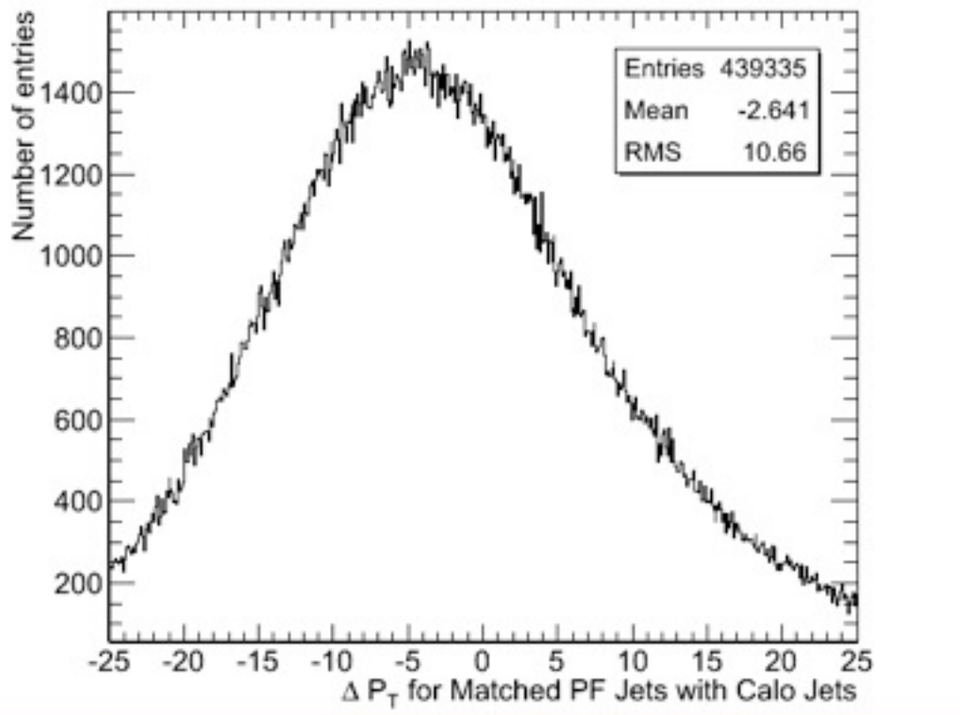


$$H_T = \sum_{jets_{50}} |\vec{p_T}|$$



Number of Jets





- There are no big differences in the jet multiplicity for Calo jets and Particle Flow jets, however one can see a slight difference in pt for matched jets, this may be related to the manual cleaning that was applied, corrections due to the removed jets are needed.

Conclusions

- Simply changing standard RECO leptons by particle flow leptons does not improve any result
- As expected, main differences between Particle Flow and Standard RECO come from Jets and MET
- For soft leptons pt < 10 GeV, significance increase when one uses the complete Particle Flow framework

Backup

Single Lepton Selection

Sample	e				mu			
	V+j pt10	SL opt:pt10	SL opt:pt5	SL opt:pt2	V+j pt10	SL opt:pt10	SL opt:pt5	SL opt:pt2
LM0 SR SRL	115.066	137.749	140.698	140.95	140.427	164.973	197.862	212.978
LM0 SR PFL	137.244	122.769	125.388	125.641	128.823	124.282	148.693	158.977
LM1 SR SRL	15.28	18.92	19.87	19.91	18.98	22.12	29.98	32.97
LM1 SR PFL	18.07	17.10	17.98	18.01	17.64	18.35	24.87	27.23
BB SR SRL	0	0	0	0	0	0	0	6578.15
BB SR PFL	0	0	0	0	0	0	0	0
QCD 250 SR SRL	0	0	0	0	0	0	0	0
QCD 250 SR PFL	0	0	0	0	0	0	0	0
QCD 500 SR SRL	0	3.43	6.86	6.86	0	6.86	20.6	41.20
QCD 500 SR PFL	0	3.43	6.86	6.86	3.43	6.86	20.6	37.77
QCD 1000 SR SRL	0.18	0.19	0.21	0.24	0.03	0.33	1.22	2.73
QCD 1000 SR PFL	0.21	0.17	0.18	0.20	0.11	0.19	0.82	1.74
TTBar SR SRL	114.45	137.57	139.189	139.24	109.83	124.64	138.64	143.38
TTBar SR PFL	125.07	108.61	110.14	110.2	103.20	98.66	110.26	113.851
WJets SR SRL	685.45	738.69	738.69	738.69	266.19	286.16	326.09	346.05
WJets SR PFL	705.41	692.1	692.1	692.1	272.85	259.54	292.81	306.12
Sig LM0 SR SRL	4.067994	4.64383448	4.7296478	4.73790212	7.2414881	8.06918971	8.97012833	2.52553756
Sig LM0 SR PFL	4.76183	4.32889433	4.4076446	4.41631981	6.6120485	6.50299052	7.21700144	7.41652591
Sig LM1 SR SRL	0.540203	0.63783656	0.667942	0.66925599	0.9787537	1.08193751	1.35915157	0.39096514
Sig LM1 SR PFL	0.626958	0.60295427	0.6320338	0.63305704	0.9054015	0.96015413	1.20709667	1.27032213

Standard RECO Framework

Sample	e				mu			
	V+j pt10	SL opt:pt10	SL opt:pt5	SL opt:pt2	V+j pt10	SL opt:pt10	SL opt:pt5	SL opt:pt2
LM0 PF SRL	68.74	86.79	88.88	89.08	114.018	134.702	161.907	174.345
LM0 PF PFL	83.32	74.76	76.58	76.68	104.646	100.804	120.829	129.541
LM1 PF SRL	8.9	11.80	12.60	12.64	15.67	18.35	24.79	27.22
LM1 PF PFL	10.87	10.56	11.31	11.34	14.52	15.13	20.45	22.37
BB PF SRL	0	0	0	0	0	0	0	0
BB PF PFL	0	0	0	0	0	0	0	0
QCD 250 PF SRL	0	0	0	0	0	0	0	0
QCD 250 PF PFL	0	0	0	0	0	0	0	0
QCD 500 PF SRL	0	3.43	3.43	3.43	0	0	10.30	13.73
QCD 500 PF PFL	0	0	0	0	0	0	10.3	17.16
QCD 1000 PF SRL	0.053	0.058	0.076	0.094	0.017	0.18	0.53	1.05
QCD 1000 PF PFL	0.076	0.07	0.082	0.088	0.06	0.094	0.39	0.73
TTBar PF SRL	36.35	47.09	47.98	48.01	59.03	66.9	75.23	77.75
TTBar PF PFL	41.07	37.31	38.12	38.15	54.03	52.09	58.83	60.85
WJets PF SRL	73.20	86.51	86.51	86.51	206.302	219.612	252.612	259.541
WJets PF PFL	73.2	66.54	66.54	66.54	206.302	199.647	232.921	239.57
Sig LM0 PF SRL	6.565961	7.41258981	7.5660777	7.58178458	6.9994625	7.95547759	8.79783838	9.29168268
Sig LM0 PF PFL	7.791818	7.33364231	7.4826414	7.49112514	6.4849826	6.35218548	6.94785664	7.26076037
Sig LM1 PF SRL	0.850117	1.00781841	1.0725988	1.07581676	0.9619672	1.08374793	1.34705981	1.45068458
Sig LM1 PF PFL	1.016527	1.03589169	1.1051015	1.10784245	0.8998141	0.95342016	1.17590701	1.25383631

Particle Flow Framework

Single Lepton Selection after cleaning jets

Sample	e				mu			
	V+j pt10	SL opt:pt10	SL opt:pt5	SL opt:pt2	V+j pt10	SL opt:pt10	SL opt:pt5	SL opt:pt2
LM0 SR SRL	83.67	111.075	114.214	114.394	139.9	170.35	203.36	218.47
LM0 SR PFL	102.57	92.24	95.04	95.2	128.13	123.43	147.75	157.82
LM1 SR SRL	11.09	14.98	15.9	15.95	18.64	22.04	29.83	32.86
LM1 SR PFL	13.52	13.1	13.97	14.01	17.4	18.00	24.42	26.81
BB SR SRL	0	0	0	0	0	0	0	8316.97
BB SR PFL	0	0	0	0	0	0	0	0
QCD 250 SR SRL	0	0	0	0	0	0	0	73.77
QCD 250 SR PFL	0	0	0	0	0	0	0	0
QCD 500 SR SRL	0	0	4.8	4.8	0	4.8	19.21	38.42
QCD 500 SR PFL	0	4.8	9.6	9.6	4.8	4.8	14.4	28.81
QCD 1000 SR SRL	0.12	0.15	0.17	0.2	0.03	0.32	1.2	2.79
QCD 1000 SR PFL	0.17	0.15	0.16	0.17	0.08	0.16	0.78	1.7
TTBar SR SRL	67.32	83.15	84.65	84.71	109.477	124.25	138.29	143.05
TTBar SR PFL	74.66	66.23	67.7	67.76	101.89	97.31	108.94	112.53
WJets SR SRL	117.47	150.1	150.1	150.1	254.51	267.57	313.25	339.35
WJets SR PFL	130.52	123.99	123.99	123.99	261.04	241.46	280.62	300.2
Sig LM0 SR SRL	6.153038	7.27052707	7.3767864	7.38702556	7.3325812	8.55026756	9.36089854	2.31391269
Sig LM0 SR PFL	7.157692	6.60256618	6.6961133	6.70622115	6.6809629	6.6575128	7.34411427	7.49622418
Sig LM1 SR SRL	0.815551	0.98053113	1.0269398	1.02997585	0.9769787	1.10623949	1.37310977	0.34803484
Sig LM1 SR PFL	0.943473	0.93770183	0.9842667	0.98691343	0.9072719	0.97087605	1.21382924	1.27343664

Sample	e				mu			
	V+j pt10	SL opt:pt10	SL opt:pt5	SL opt:pt2	V+j pt10	SL opt:pt10	SL opt:pt5	SL opt:pt2
LM0 PF SRL	68.74	93.11	95.35	95.53	113.72	139.34	166.591	178.96
LM0 PF PFL	83.54	74.93	76.905	76.99	104.82	100.78	120.76	129.34
LM1 PF SRL	8.98	12.42	13.20	13.24	15.45	18.34	24.82	27.31
LM1 PF PFL	11.03	10.69	11.44	11.48	14.4	14.92	20.27	22.23
BB PF SRL	0	0	0	0	0	0	0	0
BB PF PFL	0	0	0	0	0	0	0	0
QCD 250 PF SRL	0	0	0	0	0	0	0	0
QCD 250 PF PFL	0	0	0	0	0	0	0	0
QCD 500 PF SRL	0	4.8	4.8	4.8	0	0	9.6	9.6
QCD 500 PF PFL	0	0	0	0	0	0	4.8	4.8
QCD 1000 PF SRL	0.05	0.04	0.07	0.1	0.009	0.14	0.48	1.01
QCD 1000 PF PFL	0.08	0.06	0.08	0.08	0.05	0.07	0.35	0.66
TTBar PF SRL	36.18	46.82	47.73	47.76	58.86	66.64	74.99	77.51
TTBar PF PFL	40.85	37.04	37.86	37.89	53.75	51.78	58.51	60.56
WJets PF SRL	78.31	97.89	97.89	97.89	195.78	215.36	254.51	261.04
WJets PF PFL	78.31	71.78	71.78	71.78	202.30	189.25	228.41	234.94
Sig LM0 PF SRL	6.422897	7.61382899	7.77261	7.78573106	7.1263289	8.29551733	9.04025088	9.57731405
Sig LM0 PF PFL	7.650388	7.18094626	7.3419543	7.34906443	6.5499708	6.49046405	7.06609755	7.45552906
Sig LM1 PF SRL	0.839069	1.01561332	1.0760194	1.079065	0.9681831	1.09186011	1.34688565	1.4615358
Sig LM1 PF PFL	1.0101	1.02448039	1.0921521	1.09582101	0.8998243	0.96088235	1.18606987	1.28140104

Standard RECO Framework

Particle Flow Framework

Same Sign Double Lepton Selection

Sample	e e				mu mu				e mu			
SSDL	V+j pt10	optpt10	optpt5	optpt2	V+j pt10	optpt10	optpt5	optpt2	V+j pt10	optpt10	optpt5	optpt2
LM0 SR SRL	1.51	2.21	2.32	2.34	3.49	4.38	6.61	8.36	3.82	7.85	10.24	11.58
LM0 SR PFL	1.88	1.51	1.64	1.64	3.84	3.7	5.33	6.5	3.99	4.96	6.63	7.45
LM1 SR SRL	0.22	0.39	0.44	0.44	0.6	0.77	1.48	1.74	0.79	1.22	1.74	1.95
LM1 SR PFL	0.32	0.29	0.33	0.33	0.67	0.67	1.18	1.39	0.84	1	1.39	1.52
BB SR SRL	0	0	0	0	0	0	0	0	0	0	0	0
BB SR PFL	0	0	0	0	0	0	0	0	0	0	0	0
QCD 250 SR SRL	0	0	0	0	0	0	0	0	0	0	0	0
QCD 250 SR PFL	0	0	0	0	0	0	0	0	0	0	0	0
QCD 500 SR SRL	0	0	0	0	0	0	0	0	0	0	0	0
QCD 500 SR PFL	0	0	0	0	0	0	0	0	0	0	0	0
QCD 1000 SR SRL	0	0	0	0	0	0	0	0.023	0	0.0058	0.0058	0.011
QCD 1000 SR PFL	0	0	0	0	0	0	0	0.029	0	0.0058	0.0058	0.011
TTBar SR SRL	0.086	0.4	0.49	0.49	0.028	0.52	1.27	1.99	0.28	2.42	4.19	5.23
TTBar SR PFL	0.14	0.17	0.2	0.2	0.46	0.4	0.83	1.15	0.37	0.89	1.82	2.25
Wjets SR SRL	0	0	0	0	0	0	0	0	0	0	0	6.65
Wjets SR PFL	0	0	0	0	0	0	0	0	0	0	0	0
Sig LM0 SR SRL	5.149057263	3.494316814	3.314285714	3.342857143	20.85673923	6.073967149	5.865426527	5.892293754	7.219121434	5.040134904	4.999108553	3.358144423
Sig LM0 SR PFL	5.024511348	3.662287938	3.667151483	3.667151483	5.661771116	5.850213671	5.850435057	5.98627211	6.559519593	5.240541294	4.906670867	4.954570261
Sig LM1 SR SRL	0.750193773	0.616644144	0.628571429	0.628571429	3.585685828	1.067797878	1.313287634	1.226386499	1.492959668	0.78330759	0.849457899	0.565490641
Sig LM1 SR PFL	0.855235974	0.703353313	0.737902433	0.737902433	0.987861106	1.059363016	1.295218268	1.280141267	1.380951493	1.056560745	1.028698719	1.010865342

Sample	e e				mu mu				e mu			
SSDL	V+j pt10	optpt10	optpt5	optpt2	V+j pt10	optpt10	optpt5	optpt2	V+j pt10	optpt10	optpt5	optpt2
LM0 PF SRL	1.26	1.9	2.01	2.03	4.26	4.15	5.64	6.73	3.25	6.55	8.34	9.35
LM0 PF PFL	1.47	1.14	1.24	1.24	3.51	3.33	4.73	5.66	3.27	3.97	5.23	5.86
LM1 PF SRL	0.21	0.37	0.4	0.4	0.76	0.8	1.38	1.59	0.71	1.13	1.6	1.79
LM1 PF PFL	0.29	0.25	0.29	0.29	0.63	0.62	1.10	1.3	0.73	0.88	1.22	1.33
BB PF SRL	0	0	0	0	0	0	0	0	0	0	0	0
BB PF PFL	0	0	0	0	0	0	0	0	0	0	0	0
QCD 250 PF SRL	0	0	0	0	0	0	0	0	0	0	0	0
QCD 250 PF PFL	0	0	0	0	0	0	0	0	0	0	0	0
QCD 500 PF SRL	0	0	0	0	0	0	0	0	0	0	0	0
QCD 500 PF PFL	0	0	0	0	0	0	0	0	0	0	0	0
QCD 1000 PF SRL	0	0	0	0	0	0	0	0.011	0	0	0	0.0058
QCD 1000 PF PFL	0	0	0	0	0	0	0	0.023	0	0	0	0.0058
TTBar PF SRL	0.028	0.086	0.086	0.086	0.11	0.28	0.72	0.98	0.057	0.98	1.7	1.99
TTBar PF PFL	0	0.028	0.028	0.028	0.28	0.28	0.57	0.78	0.028	0.34	0.78	0.89
Wjets PF SRL	0	0	0	0	0	0	0	0	0	0	0	0
Wjets PF PFL	0	0	0	0	0	0	0	0	0	0	0	0
Sig LM0 PF SRL	7.529940239	6.478946225	6.854043112	6.922242546	12.84438328	7.842762815	6.646803743	6.760490969	13.61275202	6.616499167	6.396488007	6.618401378
Sig LM0 PF PFL	⚠	6.812803073	7.410417378	7.410417378	6.633276501	6.293108476	6.265038049	6.316240507	19.54198776	6.80849383	5.921808889	6.191445964
Sig LM1 PF SRL	1.25499004	1.261689528	1.363988679	1.363988679	2.291486219	1.511857892	1.626345597	1.597203661	2.973862749	1.141472375	1.227143982	1.267052242
Sig LM1 PF PFL	⚠	1.494035762	1.733081484	1.733081484	1.19058809	1.171689866	1.456985593	1.450726618	4.362584424	1.509187549	1.381377982	1.40522579

Standard RECO Framework

Particle Flow Framework

Same Sign Double Lepton Selection after cleaning

Sample	e e				mu mu				e mu			
SSDL	V+j pt10	optpt10	optpt5	optpt2	V+j pt10	optpt10	optpt5	optpt2	V+j pt10	optpt10	optpt5	optpt2
LM0 SR SRL	1.39	2.17	2.28	2.28	3.38	4.61	6.97	8.76	3.67	7.44	9.77	11.03
LM0 SR PFL	1.61	1.21	1.34	1.34	3.6	3.45	5.08	6.34	3.83	4.61	6.21	6.97
LM1 SR SRL	0.25	0.43	0.46	0.46	0.62	0.8	1.5	1.77	0.77	1.23	1.74	1.96
LM1 SR PFL	0.33	0.29	0.33	0.33	0.67	0.67	1.17	1.4	0.81	0.95	1.32	1.45
BB SR SRL	0	0	0	0	0	0	0	0	0	0	0	0
BB SR PFL	0	0	0	0	0	0	0	0	0	0	0	0
QCD 250 SR SRL	0	0	0	0	0	0	0	0	0	0	0	0
QCD 250 SR PFL	0	0	0	0	0	0	0	0	0	0	0	0
QCD 500 SR SRL	0	0	0	0	0	0	0	0	0	0	0	0
QCD 500 SR PFL	0	0	0	0	0	0	0	0	0	0	0	0
QCD 1000 SR SRL	0	0	0	0	0	0	0	0.009	0	0.01	0.01	0.01
QCD 1000 SR PFL	0	0	0	0	0	0	0	0.009	0	0.009	0.009	0.01
TTBar SR SRL	0.02	0.17	0.23	0.23	0.029	0.52	1.29	1.96	0.11	1.23	2.23	2.7
TTBar SR PFL	0.02	0.05	0.05	0.05	0.46	0.411	0.85	1.17	0.05	0.35	0.82	1.02
Wjets SR SRL	0	0	0	0	0	0	0	0	0	0	0	0
Wjets SR PFL	0	0	0	0	0	0	0	0	0	0	0	0
Sig LM0 SR SRL	9.828784258	5.263023063	4.754128641	4.754128641	19.84804342	6.392919761	6.136742817	6.242826254	11.06546635	6.681317235	6.527855834	6.700247834
Sig LM0 SR PFL	11.38441918	5.411284506	5.99266218	5.99266218	5.307910422	5.381436055	5.510033629	5.83891772	17.12828071	7.694026913	6.820470501	6.867745069
Sig LM1 SR SRL	1.767766953	1.042903188	0.959166305	0.959166305	3.640765361	1.109400392	1.320676359	1.261392976	2.321637353	1.104572607	1.162586402	1.190615209
Sig LM1 SR PFL	2.333452378	1.296919427	1.475804865	1.475804865	0.987861106	1.04509048	1.269043178	1.289350916	3.622430124	1.585536999	1.449761846	1.428727453

Sample	e e				mu mu				e mu			
SSDL	V+j pt10	optpt10	optpt5	optpt2	V+j pt10	optpt10	optpt5	optpt2	V+j pt10	optpt10	optpt5	optpt2
LM0 PF SRL	1.34	2.13	2.24	2.24	3.96	4.3	5.87	7.06	3.38	6.92	8.96	10.04
LM0 PF PFL	1.56	1.18	1.3	1.3	3.29	3.09	4.43	5.44	3.40	4.12	5.47	6.16
LM1 PF SRL	0.24	0.4	0.44	0.44	0.78	0.85	1.43	1.63	0.74	1.20	1.7	1.92
LM1 PF PFL	0.31	0.27	0.31	0.31	0.64	0.64	1.12	1.33	0.75	0.9	1.27	1.39
BB PF SRL	0	0	0	0	0	0	0	0	0	0	0	0
BB PF PFL	0	0	0	0	0	0	0	0	0	0	0	0
QCD 250 PF SRL	0	0	0	0	0	0	0	0	0	0	0	0
QCD 250 PF PFL	0	0	0	0	0	0	0	0	0	0	0	0
QCD 500 PF SRL	0	0	0	0	0	0	0	0	0	0	0	0
QCD 500 PF PFL	0	0	0	0	0	0	0	0	0	0	0	0
QCD 1000 PF SRL	0	0	0	0	0	0	0	0	0	0.009	0.009	0.009
QCD 1000 PF PFL	0	0	0	0	0	0	0	0.009	0	0	0	0.009
TTBar PF SRL	0.02	0.08	0.08	0.08	0.11	0.29	0.73	0.96	0.05	0.99	1.73	2.02
TTBar PF PFL	0	0.02	0.02	0.02	0.29	0.29	0.58	0.79	0.02	0.35	0.79	0.91
Wjets PF SRL	0	0	0	0	0	0	0	0	0	0	0	0
Wjets PF PFL	0	0	0	0	0	0	0	0	0	0	0	0
Sig LM0 PF SRL	9.475230868	7.53068722	7.919595949	7.919595949	11.93984925	7.984899542	6.87031534	7.205582327	15.11581953	6.923462597	6.794511197	7.048434841
Sig LM0 PF PFL	⚠	8.343860018	9.192388155	9.192388155	6.109376626	5.73798595	5.816874976	6.085909782	24.04163056	6.964071059	6.154230818	6.425737151
Sig LM1 PF SRL	1.697056275	1.414213562	1.555634919	1.555634919	2.351788488	1.578410375	1.673688405	1.663611784	3.309380607	1.20060045	1.289137169	1.347907858
Sig LM1 PF PFL	⚠	1.909188309	2.192031022	2.192031022	1.188450164	1.188450164	1.470632048	1.487915443	5.303300859	1.521277659	1.428861634	1.449963416

Standard RECO Framework

Particle Flow Framework

Opposite Sign Double Lepton Selection

Sample	e e				mu mu				e mu			
OSDL	V+j pt10	opt:pt10	opt:pt5	opt:pt2	V+j pt10	opt:pt10	opt:pt5	opt:pt2	V+j pt10	opt:pt10	opt:pt5	opt:pt2
LM0 SR SRL	8.61	12.34	12.76	12.78	18.55	22.29	28.38	31.12	13.50	21.05	26.04	27.9
LM0 SR PFL	10.67	9.48	9.81	9.81	13.64	12.69	15.93	17.25	14.43	16.41	19.3	20.33
LM1 SR SRL	2.31	2.97	3.09	3.1	4.83	5.41	6.95	7.46	1.41	2.19	3.13	3.44
LM1 SR PFL	2.9	2.52	2.61	2.61	3.84	3.58	4.62	4.93	1.48	1.75	2.51	2.73
BB SR SRL	0	0	0	0	0	0	0	0	0	0	0	0
BB SR PFL	0	0	0	0	0	0	0	0	0	0	0	0
QCD 250 SR SRL ⊞	0	0	0	0	0	0	0	0	0	0	0	0
QCD 250 SR PFL ⊞	0	0	0	0	0	0	0	0	0	0	0	0
QCD 500 SR SRL ⊞	0	0	0	0	0	0	0	0	0	0	0	0
QCD 500 SR PFL ⊞	0	0	0	0	0	0	0	0	0	0	0	0
QCD 1000 SR SRL ⊞	0	0.0058	0.011	0.011	0	0	0.0058	0.088	0	0	0.0058	0.011
QCD 1000 SR PFL ⊞	0	0	0.0058	0.0058	0	0	0.0058	0.029	0	0	0.0058	0.011
TTBar SR SRL ⊞	11.39	14.14	14.34	14.34	6.88	8.64	10.15	11.04	21.72	28.72	32.04	33.84
TTBar SR PFL	12.58	8.5	8.64	8.64	6.36	5.46	6.36	6.76	21.54	19.81	21.52	22.3
Wjets SR SRL	0	0	0	0	0	0	0	6.65	0	0	6.65	26.61
Wjets SR PFL	0	0	0	0	0	0	0	6.65	0	0	0	0
Sig LM0 SR SRL ⊞	2.551181103	3.28096353	3.368290901	3.373570354	7.072121199	7.583211995	8.905438756	7.38070993	2.896702259	3.927895114	4.186094855	3.58811654
Sig LM0 SR PFL ⊞	3.00832047	3.251613174	3.336310136	3.336310136	5.408611815	5.43081865	6.313777613	4.705498317	3.109162934	3.686942319	4.159849884	4.304055477
Sig LM1 SR SRL ⊞	0.684463223	0.789664642	0.815675461	0.818315188	1.841420237	1.840519376	2.180859738	1.769283293	0.302544458	0.408650371	0.503167316	0.442405767
Sig LM1 SR PFL ⊞	0.817631618	0.864352869	0.887642146	0.887642146	1.522659045	1.532098563	1.831114411	1.34481778	0.318888506	0.393183977	0.540996021	0.577967115

Sample	e e				mu mu				e mu			
OSDL	V+j pt10	opt:pt10	opt:pt5	opt:pt2	V+j pt10	opt:pt10	opt:pt5	opt:pt2	V+j pt10	opt:pt10	opt:pt5	opt:pt2
LM0 PF SRL	6.94	9.99	10.28	10.28	16.59	19.03	23.57	25.47	11.54	17.67	21.73	23.28
LM0 PF PFL	7.91	7.00	7.27	7.27	12.24	11.48	14.39	15.52	10.9	12.49	14.78	15.69
LM1 PF SRL	2.02	2.63	2.74	2.74	4.57	4.9	6.21	6.61	1.27	2	2.85	3.14
LM1 PF PFL	2.5	2.17	2.25	2.25	3.68	3.41	4.42	4.71	1.27	1.52	2.2	2.4
BB PF SRL	0	0	0	0	0	0	0	0	0	0	0	0
BB PF PFL	0	0	0	0	0	0	0	0	0	0	0	0
QCD 250 PF SRL ⊞	0	0	0	0	0	0	0	0	0	0	0	0
QCD 250 PF PFL ⊞	0	0	0	0	0	0	0	0	0	0	0	0
QCD 500 PF SRL ⊞	0	0	0	0	0	0	0	0	0	0	0	0
QCD 500 PF PFL ⊞	0	0	0	0	0	0	0	0	0	0	0	0
QCD 1000 PF SRL ⊞	0	0.0058	0.0058	0.0058	0	0	0.0058	0.035	0	0	0	0.0058
QCD 1000 PF PFL ⊞	0	0	0	0	0	0	0.0058	0.017	0	0	0	0
TTBar PF SRL	2.83	3.47	3.52	3.52	5.4	6.24	7.05	7.49	8.47	11.36	12.87	13.5
TTBar PF PFL	3.23	1.93	1.99	1.99	5.09	4.3	4.8	5.09	8.38	7.75	8.53	8.85
Wjets PF SRL	0	0	0	0	0	0	0	6.65	6.65	6.65	6.65	6.65
Wjets PF PFL	0	0	0	0	0	0	0	6.65	6.65	0	0	0
Sig LM0 PF SRL ⊞	4.12540179	5.358436627	5.47474982	5.47474982	7.139199302	7.618096917	8.873326286	6.764993929	2.967767764	4.163702518	4.918354404	5.185408268
Sig LM0 PF PFL ⊞	4.401241733	5.038710255	5.15356636	5.15356636	5.425284616	5.536147599	6.564141697	4.526301277	2.811557745	4.486540445	5.060575615	5.274135804
Sig LM1 PF SRL ⊞	1.200765363	1.410679512	1.459223201	1.459223201	1.966614877	1.961569884	2.337859832	1.755658024	0.326608757	0.47127363	0.645067191	0.699406442
Sig LM1 PF PFL ⊞	1.39103721	1.562000179	1.594982711	1.594982711	1.631131322	1.644448024	2.016226984	1.373639112	0.327585168	0.546000118	0.753265653	0.806751175

Standard RECO Framework

Particle Flow Framework

Opposite Sign Double Lepton Selection after cleaning jets

Sample	e e				mu mu				e mu			
OSDL	V+j pt10	opcpt10	opcpt5	opcpt2	V+j pt10	opcpt10	opcpt5	opcpt2	V+j pt10	opcpt10	opcpt5	opcpt2
LM0 SR SRL	7.37	11.65	11.99	11.99	18.27	23.6	29.99	32.71	12.26	20.33	24.64	26.41
LM0 SR PFL	8.92	8.00	8.36	8.36	13.58	12.62	15.82	17.08	12.39	14.39	16.99	18.00
LM1 SR SRL	2.08	2.88	2.98	2.98	4.83	5.68	7.24	7.8	1.34	2.12	3.07	3.39
LM1 SR PFL	2.58	2.23	2.31	2.31	3.84	3.55	4.58	4.91	1.34	1.58	2.33	2.55
BB SR SRL	0	0	0	0	0	0	0	0	0	0	0	0
BB SR PFL	0	0	0	0	0	0	0	0	0	0	0	0
QCD 250 SR SRL ⊞	0	0	0	0	0	0	0	73.77	0	0	0	0
QCD 250 SR PFL ⊞	0	0	0	0	0	0	0	0	0	0	0	0
QCD 500 SR SRL ⊞	0	0	0	0	0	0	0	0	0	0	0	0
QCD 500 SR PFL ⊞	0	0	0	0	0	0	0	0	0	0	0	0
QCD 1000 SR SRL ⊞	0	0.009	0.01	0.01	0	0	0	0.09	0	0	0.01	0.02
QCD 1000 SR PFL ⊞	0	0	0.009	0.009	0	0	0	0.09	0	0	0.009	0.01
TTBar SR SRL ⊞	3.26	4.05	4.14	4.14	6.78	8.54	9.98	10.89	9.98	13.71	15.5	16.3
TTBar SR PFL	4.05	2.64	2.73	2.73	6.25	5.4	6.31	6.69	10.51	9.57	10.48	10.89
Wjets SR SRL	0	0	0	0	0	0	0	6.52	0	0	6.52	6.52
Wjets SR PFL	0	0	0	0	0	0	0	6.52	0	0	0	0
Sig LM0 SR SRL ⊞	4.081865476	5.782510096	5.885659517	5.885659517	7.016551229	8.075753748	9.493168623	3.423864104	3.880835189	5.490585404	5.249687538	5.526120509
Sig LM0 SR PFL ⊞	4.432383635	4.923659639	5.05138257	5.05138257	5.432	5.430783314	6.297842561	4.683408565	3.821817532	4.651626383	5.245976444	5.452042795
Sig LM1 SR SRL ⊞	1.152005453	1.429496058	1.462824467	1.462824467	1.854950325	1.943655987	2.291781955	0.81645185	0.424169588	0.572554897	0.654080387	0.709335423
Sig LM1 SR PFL ⊞	1.282012307	1.372470124	1.395776763	1.395776763	1.536	1.527676764	1.823269212	1.34634286	0.413336198	0.510741465	0.719430554	0.772372729

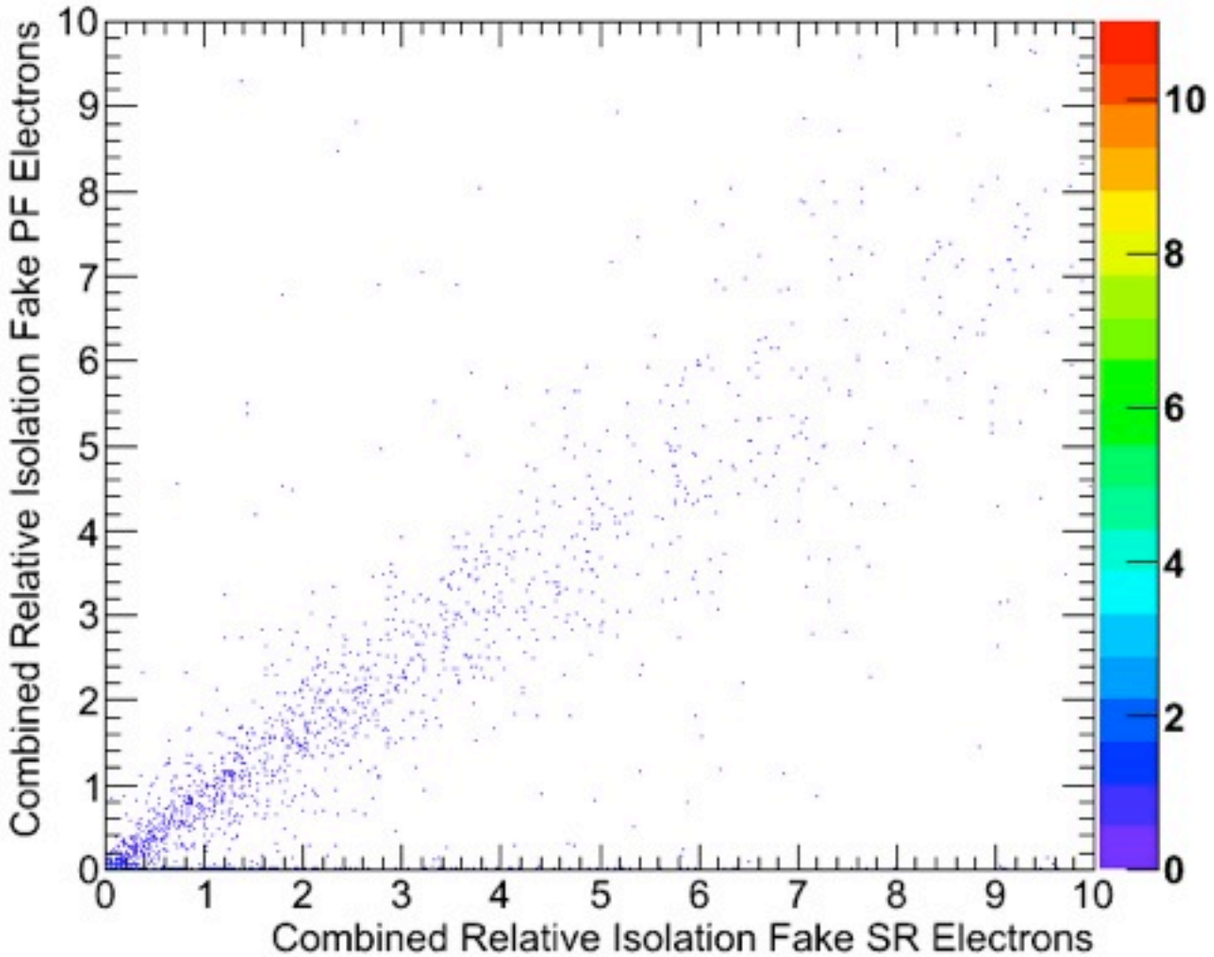
Sample	e e				mu mu				e mu			
OSDL	V+j pt10	opcpt10	opcpt5	opcpt2	V+j pt10	opcpt10	opcpt5	opcpt2	V+j pt10	opcpt10	opcpt5	opcpt2
LM0 PF SRL	6.79	10.78	11.12	11.12	16.47	19.97	24.64	26.5	11.43	18.65	22.75	24.43
LM0 PF PFL	7.84	6.92	7.21	7.21	12.26	11.45	14.32	15.42	10.85	12.44	14.68	15.53
LM1 PF SRL	2.07	2.89	3	3	4.58	5.09	6.42	6.85	1.27	2.02	2.93	3.24
LM1 PF PFL	2.54	2.19	2.28	2.28	3.68	3.38	4.37	4.68	1.26	1.49	2.2	2.41
BB PF SRL	0	0	0	0	0	0	0	0	0	0	0	0
BB PF PFL	0	0	0	0	0	0	0	0	0	0	0	0
QCD 250 PF SRL ⊞	0	0	0	0	0	0	0	0	0	0	0	0
QCD 250 PF PFL ⊞	0	0	0	0	0	0	0	0	0	0	0	0
QCD 500 PF SRL ⊞	0	0	0	0	0	0	0	0	0	0	0	0
QCD 500 PF PFL ⊞	0	0	0	0	0	0	0	0	0	0	0	0
QCD 1000 PF SRL ⊞	0	0.009	0.009	0.009	0	0	0	0.02	0	0	0.009	0.01
QCD 1000 PF PFL ⊞	0	0	0	0	0	0	0	0	0	0	0	0
TTBar PF SRL	2.81	3.46	3.52	3.52	5.37	6.22	7.02	7.43	8.37	11.27	12.74	13.33
TTBar PF PFL	3.23	1.9	1.96	1.96	5.05	4.28	4.78	5.05	8.34	7.72	8.45	8.75
Wjets PF SRL	0	0	0	0	0	0	0	6.52	6.52	6.52	6.52	6.52
Wjets PF PFL	0	0	0	0	0	0	0	6.52	6.52	0	0	0
Sig LM0 PF SRL ⊞	4.050574407	5.787841253	5.919417309	5.919417309	7.107329602	8.007240494	9.299768707	7.090023438	2.962094307	4.421716173	5.182649189	5.481934535
Sig LM0 PF PFL ⊞	4.362292691	5.020295651	5.15	5.15	5.455628395	5.5345664	6.549815546	4.533333757	2.814623656	4.47725397	5.050073525	5.25009823
Sig LM1 PF SRL ⊞	1.234858472	1.551656885	1.596965101	1.596965101	1.976415882	2.040904062	2.423072853	1.832704172	0.32912159	0.478920465	0.667479654	0.727035116
Sig LM1 PF PFL ⊞	1.413293806	1.588792988	1.628571429	1.628571429	1.637578507	1.633784666	1.998791476	1.375875615	0.326859521	0.536262734	0.756823008	0.814728702

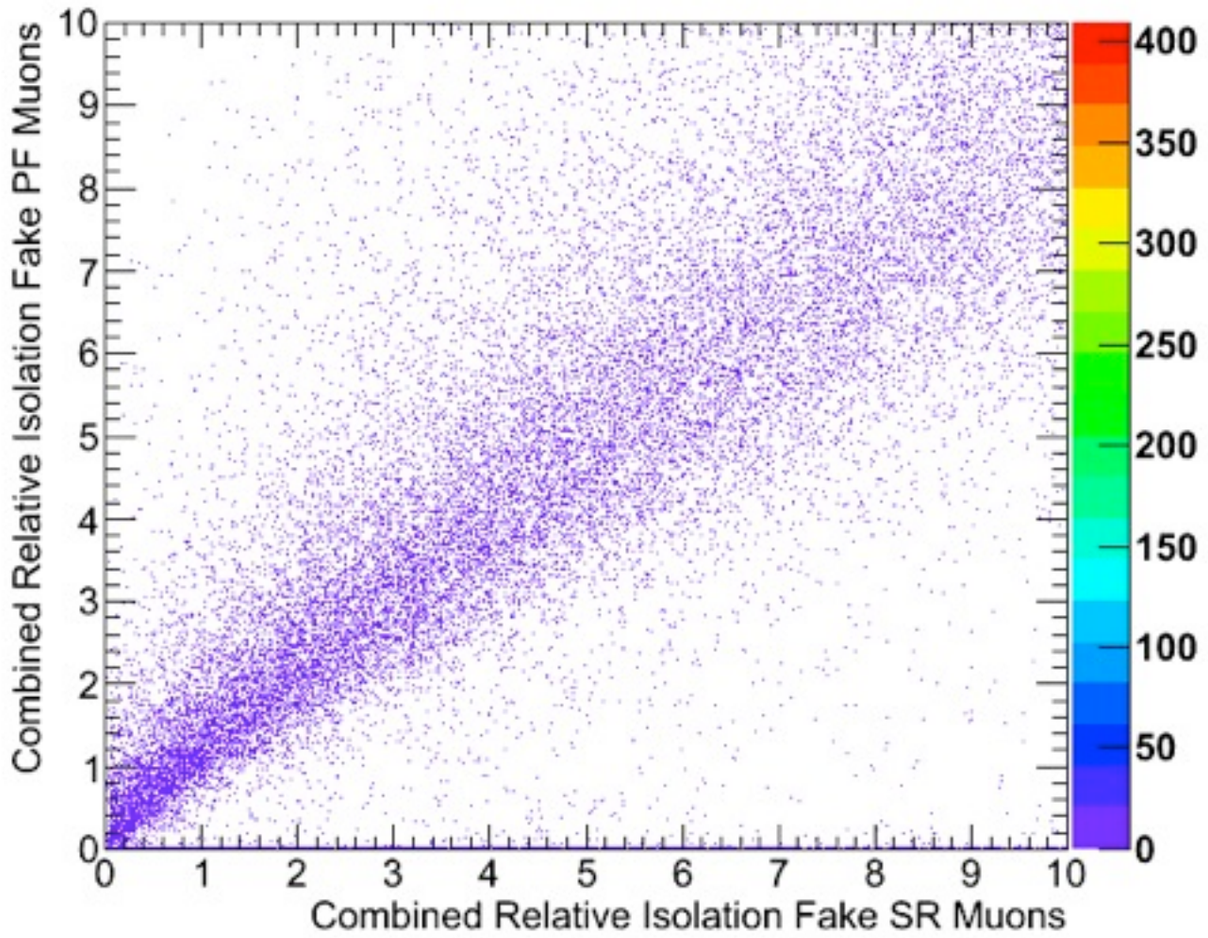
Standard RECO Framework

Particle Flow Framework

Combined relative Isolation SR vs PF

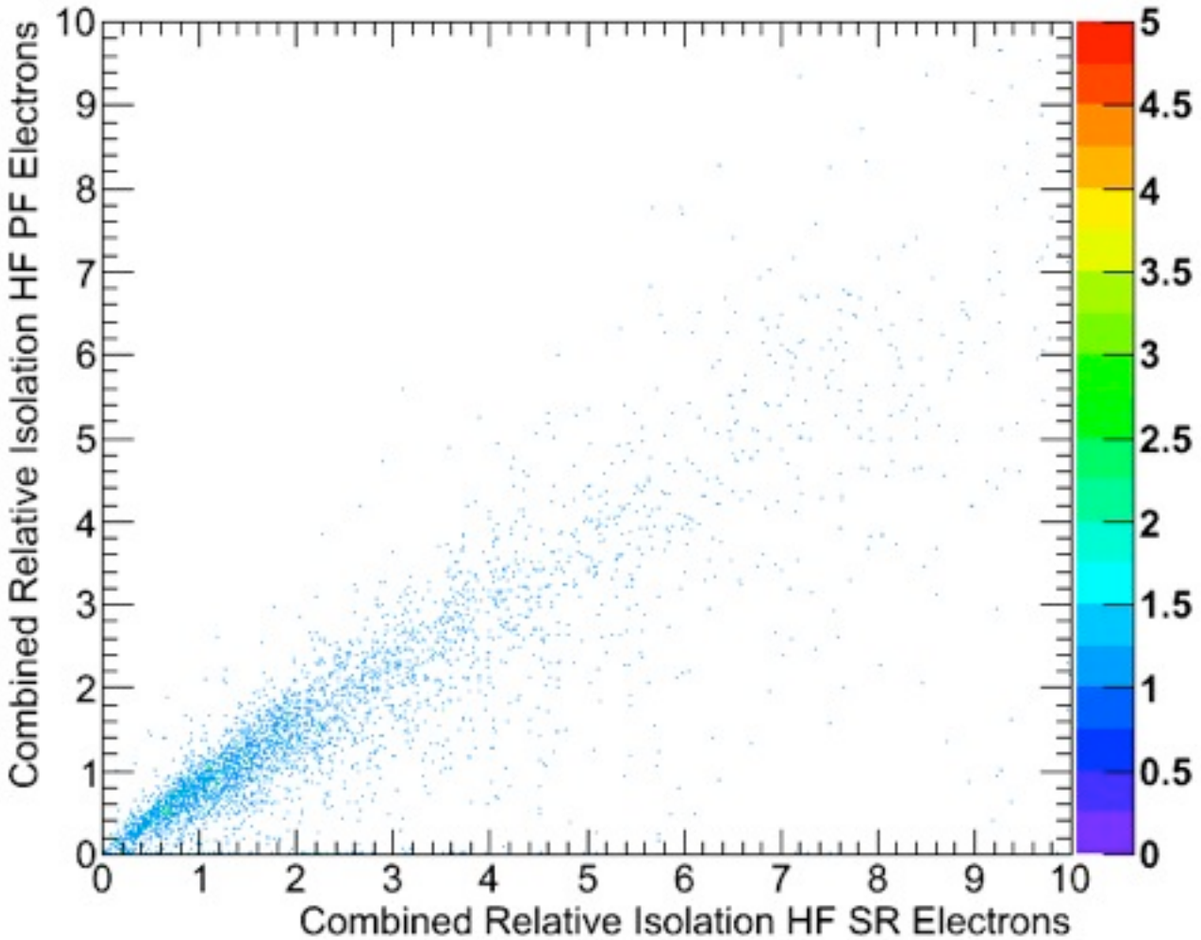
Fake leptons

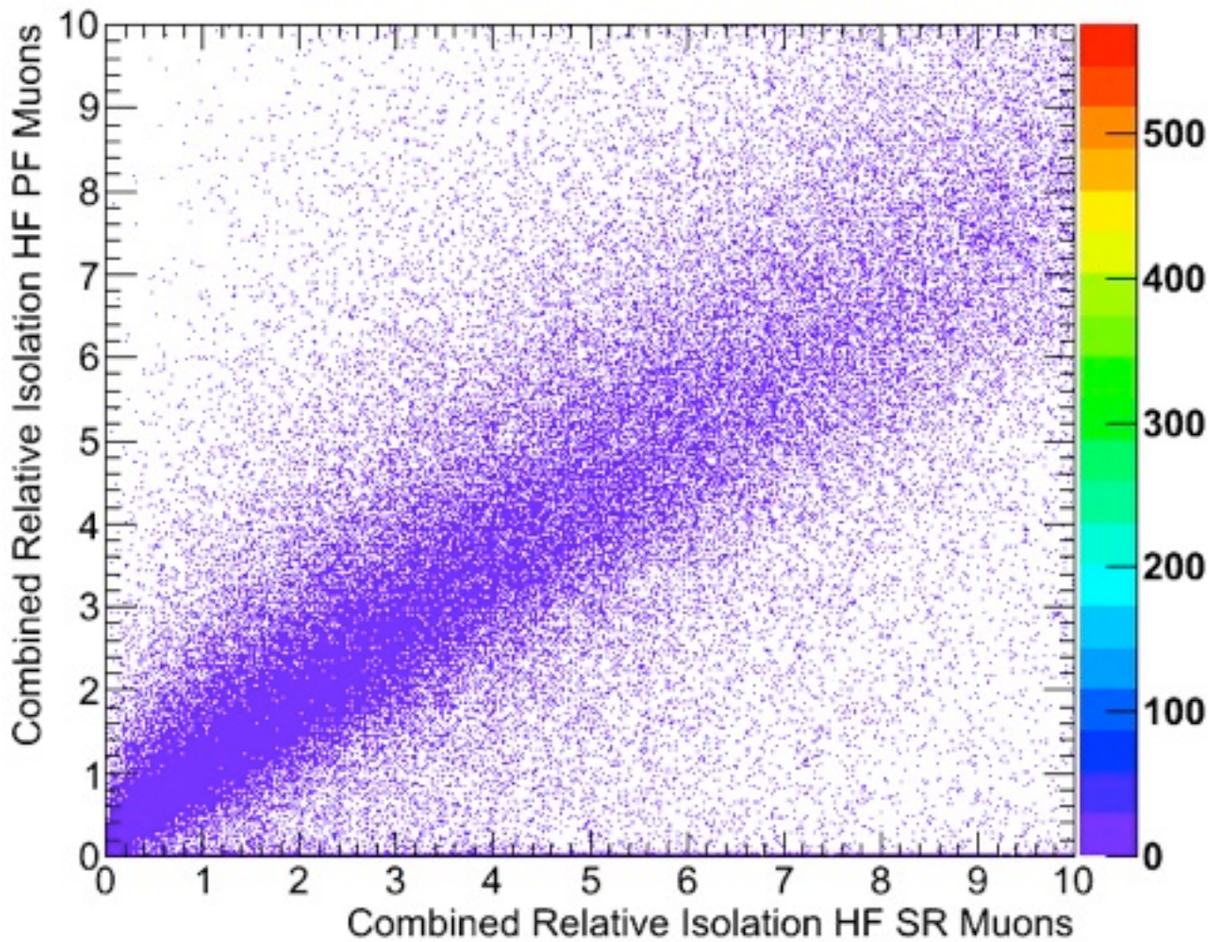




Combined relative Isolation SR vs PF

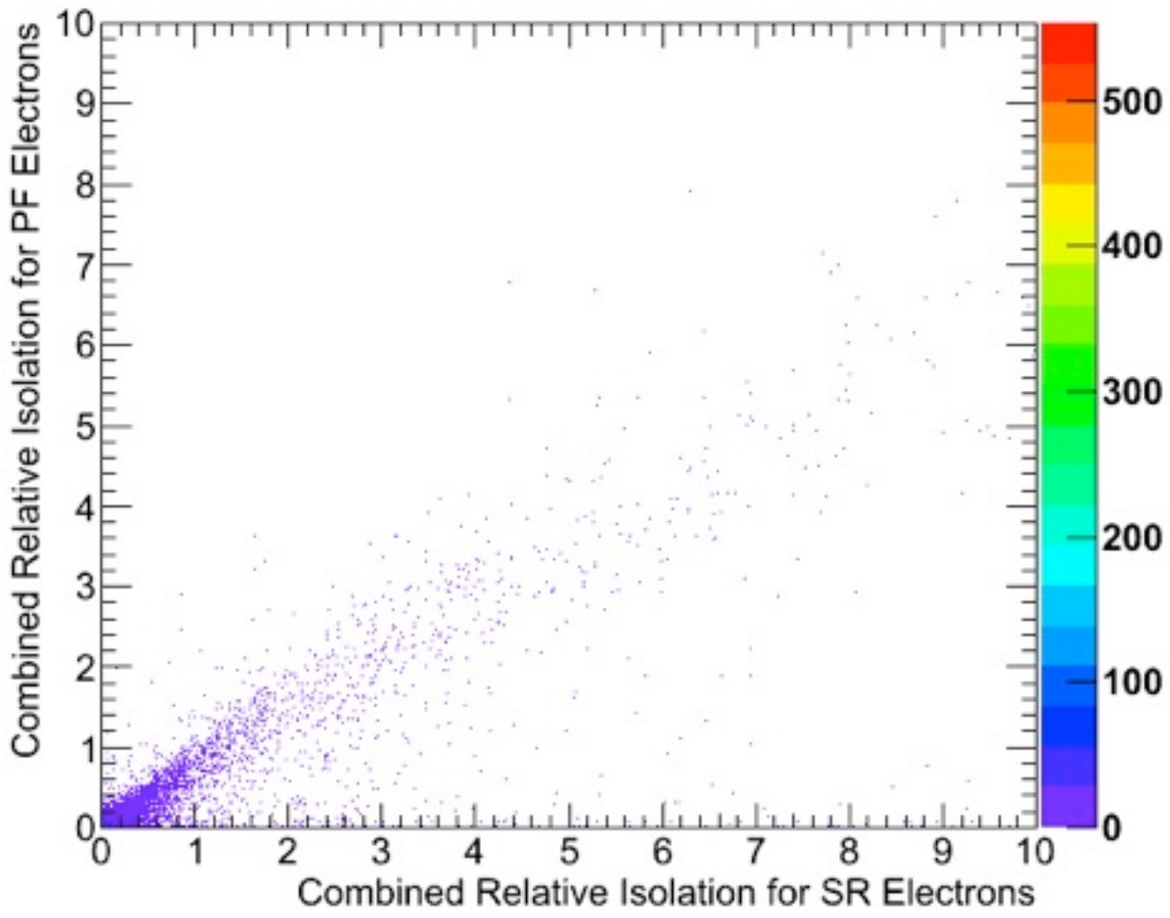
Heavy Flavour leptons

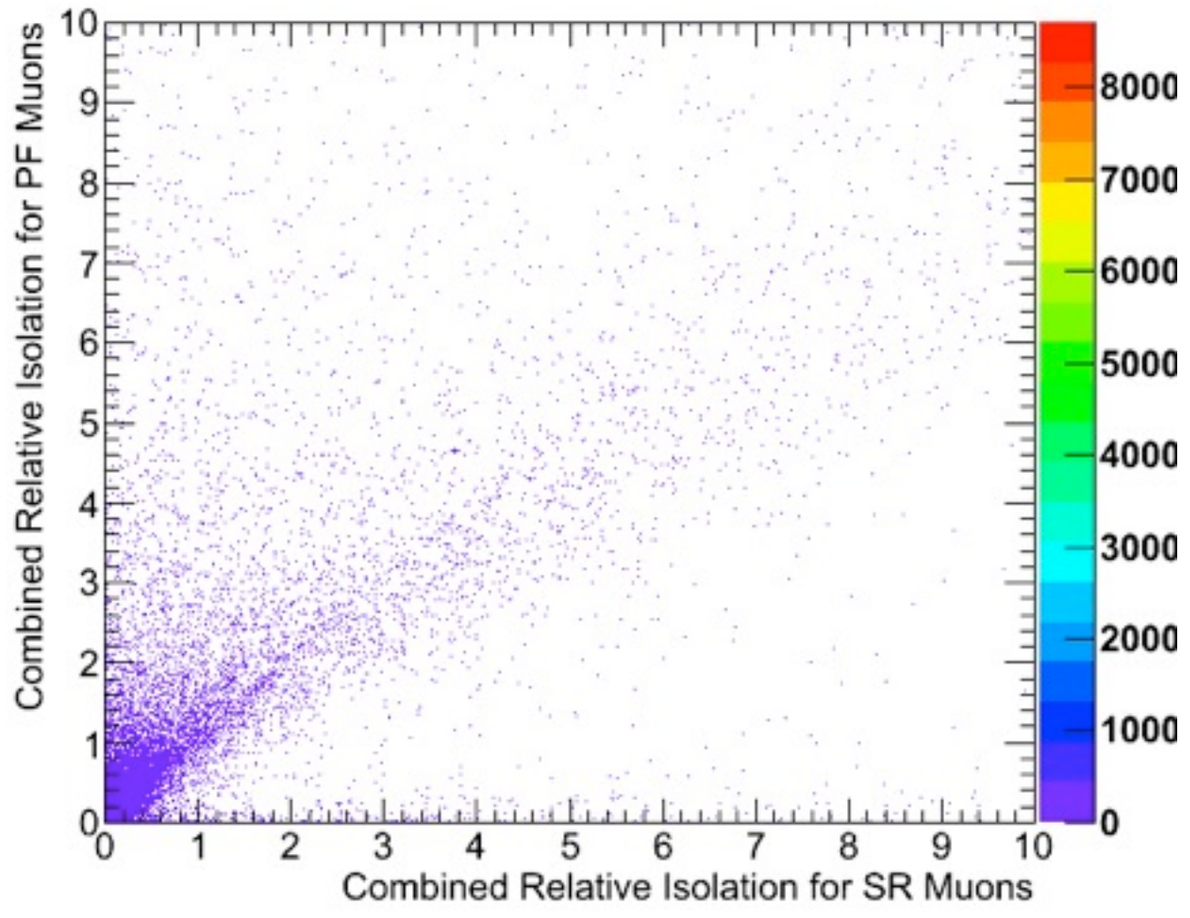




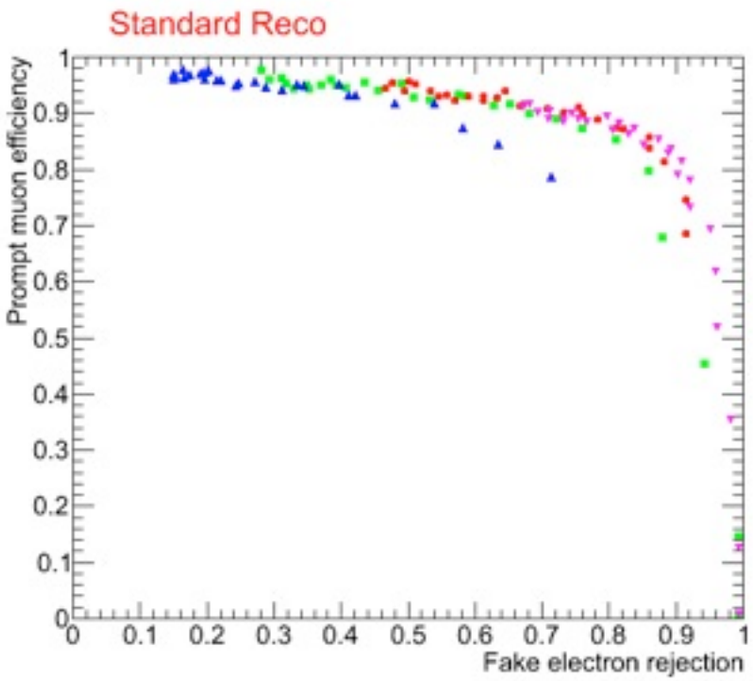
Combined relative Isolation SR vs PF

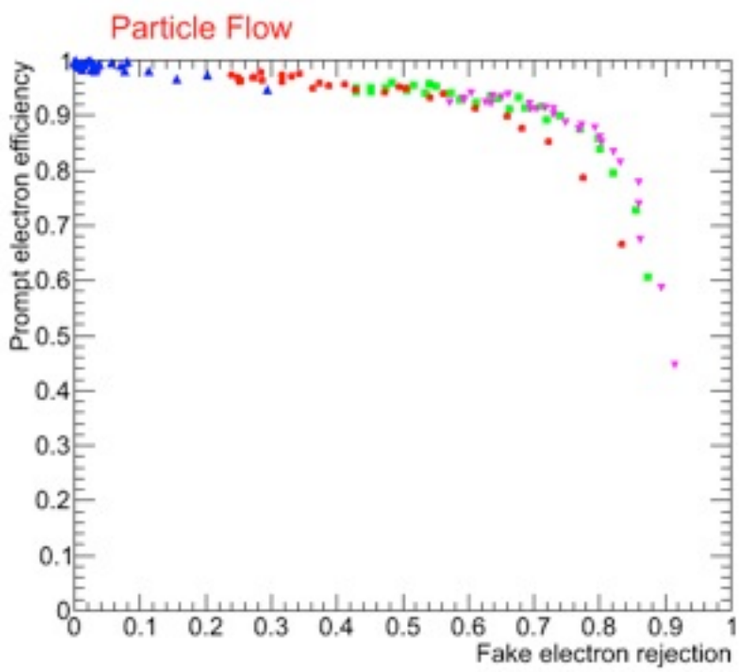
Prompt leptons



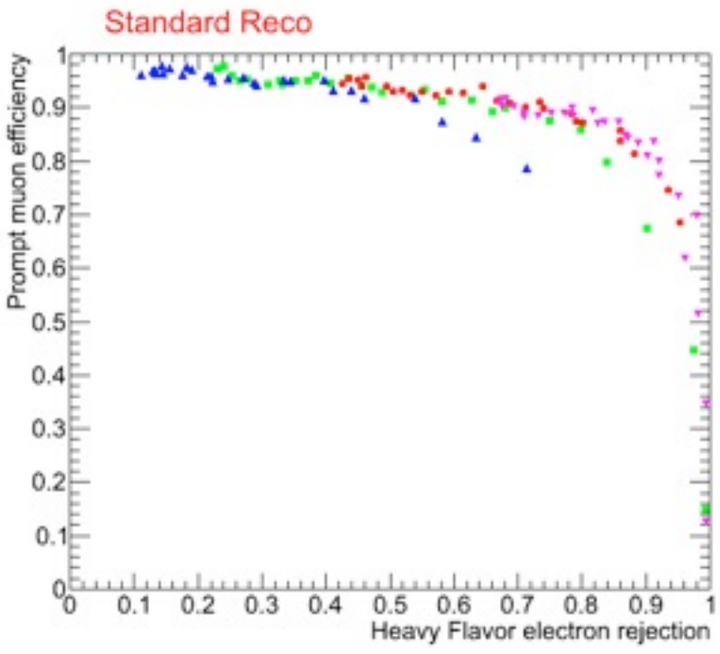


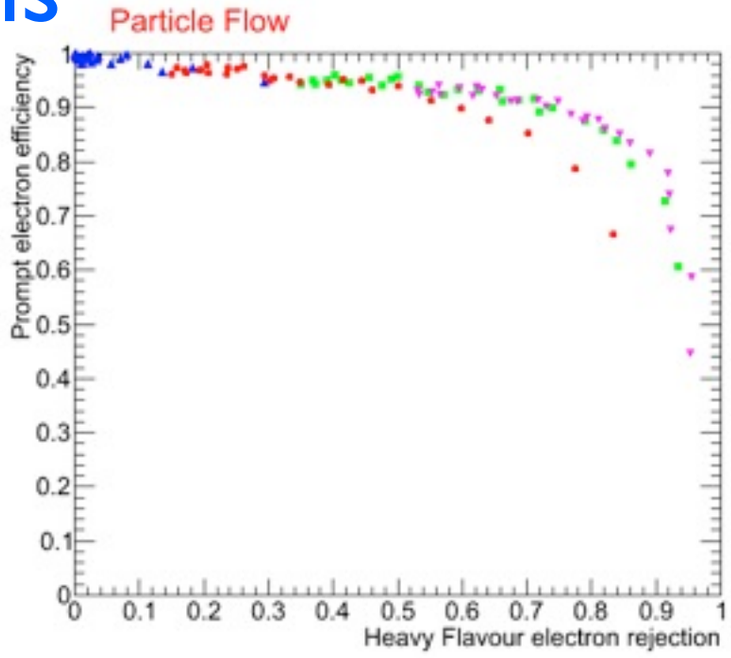
Efficiency vs Rejection





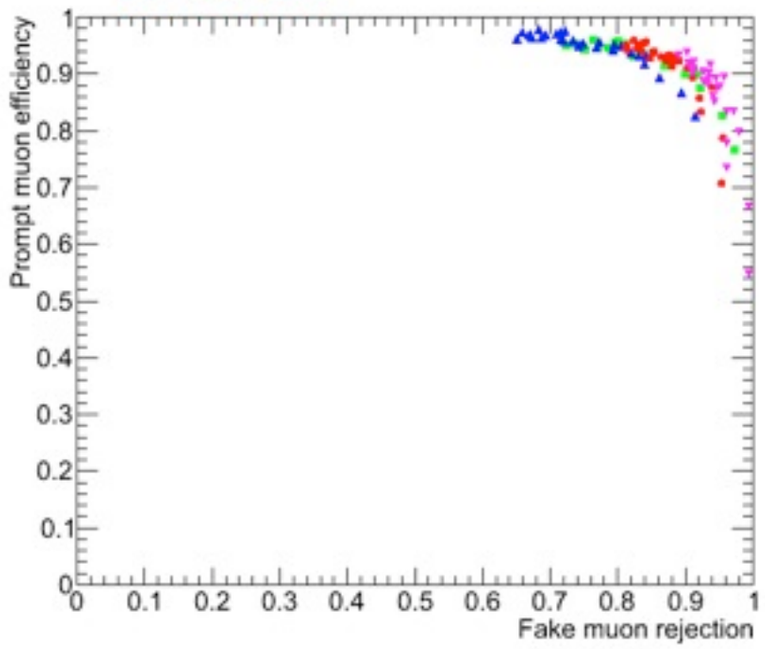
Electrons



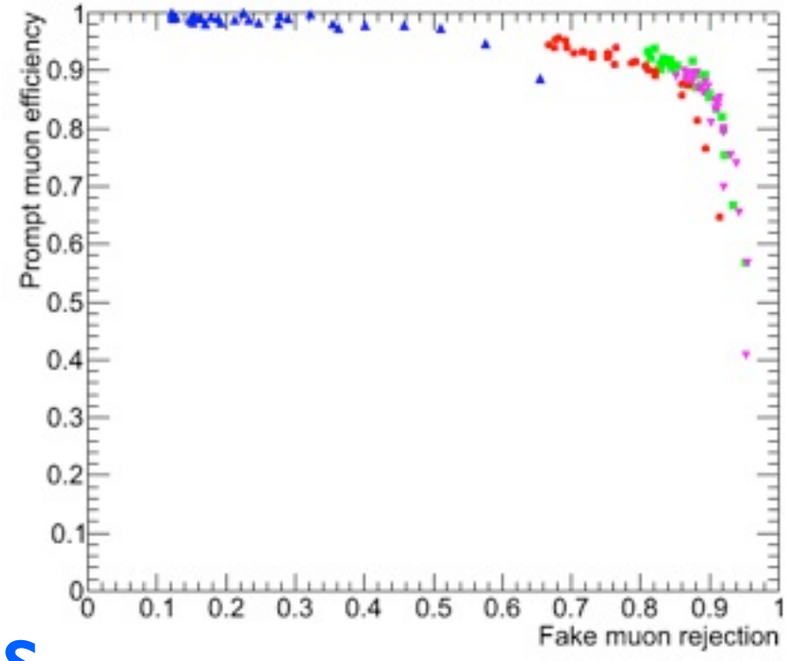


Efficiency vs Rejection

Standard Reco

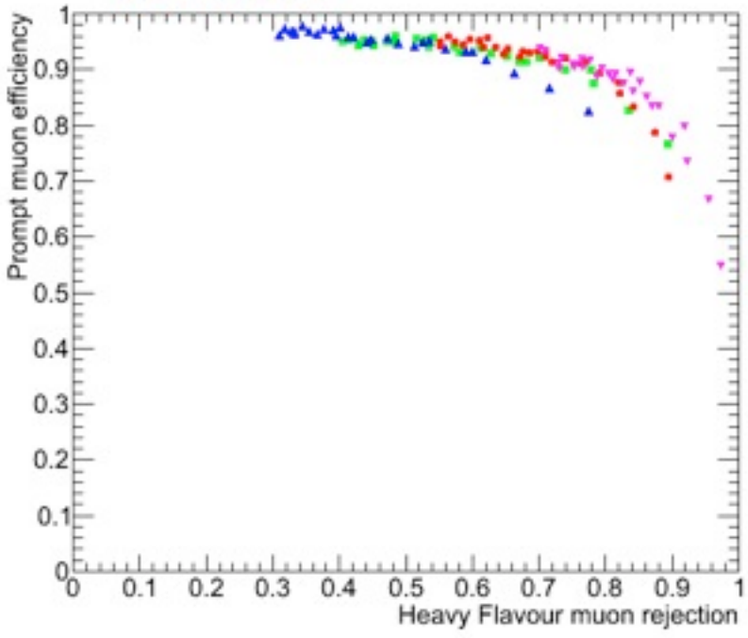


Particle Flow

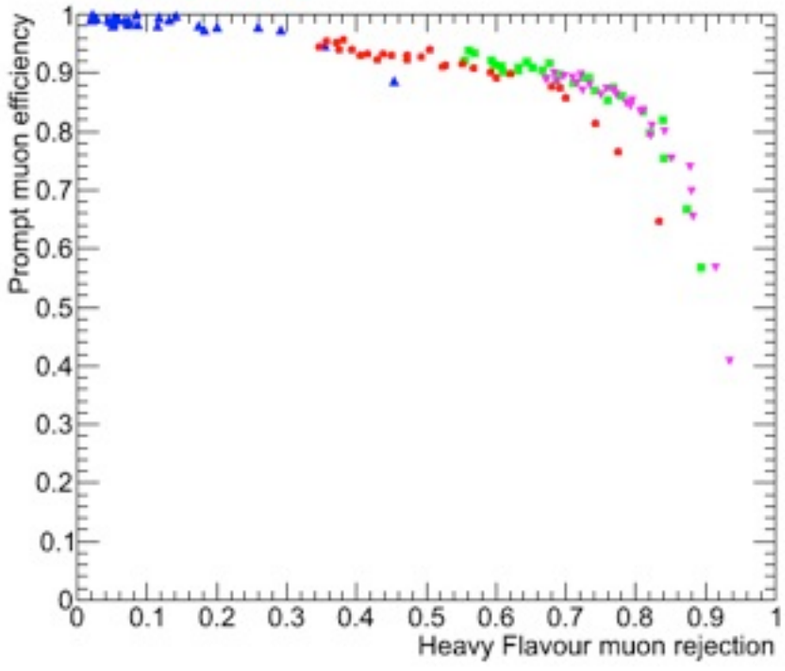


Muons

Standard Reco



Particle Flow



Combined Relative Isolation Prompt